

CLAIMS AS AMENDED FEBRUARY, 2005

1. (currently amended) Apparatus useful for purifying a gas stream, comprising

(a) a shell-and-tube heat exchanger comprising a shell inlet and a shell outlet in fluid communication with the shell inlet, and further comprising a plurality of tubes each having an inlet and an outlet;

(b) a catalyst system comprising a catalyst supported on a monolithic unitary support having passages therethrough, the support having a length and upstream and downstream ends at opposite ends of the length, wherein the diameter of said support is from one-half to two times the diameter of the shell of the heat exchanger, and wherein the downstream end of said support is connected in fluid communication with the inlets of said tubes by a passageway whose length does not exceed the length of the support and whose diameter is at no point less than the smaller of the diameter of said support and the diameter of said shell;

wherein the shell outlet of the heat exchanger is connected in fluid communication to the upstream end of the catalyst support;

further comprising a gas distributor for distributing gas equally to all catalyst passages of the catalyst support is provided between the shell outlet and the upstream end of the catalyst support,  
and

(c) a source of gas to be purified in fluid communication with said shell inlet ~~upstream end of~~ ~~said support~~.

2. (canceled)

3. (original) A method for purifying a gas stream comprising a principal component and at least one impurity, comprising providing apparatus according to claim 1, wherein the catalyst is capable of catalyzing reaction of at least one impurity in said gas stream, passing the gas stream into the upstream end of the catalyst of said apparatus under conditions effective to remove one or more impurities from said gas stream whereby said at least one impurity in said gas stream is catalytically converted to a byproduct, and removing heat from said gas stream by passing said gas stream from the downstream end of said catalyst into the second inlet and out of the second outlet of said heat exchanger.

4. (original) The method of claim 3 further comprising heating said gas stream by passing it into the first inlet and out of the first outlet of said heat exchanger and then into the upstream end of said catalyst.

5. (original) The method of claim 3 wherein the main component of said gas stream is carbon dioxide, said gas stream comprises one or more hydrocarbons as

impurities, and said method removes hydrocarbons from said gas stream.

6. (original) The method of claim 3 wherein the main component of said gas stream is argon, said gas stream comprises oxygen as an impurity, and said method removes oxygen from said gas stream.

7. (original) The method of claim 3 wherein the main component of said gas stream is helium, said gas stream comprises hydrogen as an impurity, and said method removes hydrogen from said gas stream.

8. (new) Apparatus useful for purifying a gas stream, comprising

(a) a shell-and-tube heat exchanger comprising a shell inlet and a shell outlet in fluid communication with the shell inlet, and further comprising a plurality of tubes each having an inlet and an outlet;

(b) a first catalyst system comprising a catalyst supported on a first monolithic unitary support having passages therethrough, the support having a length and upstream and downstream ends at opposite ends of the length, wherein the diameter of said first support is from one-half to two times the diameter of the shell of the heat exchanger, and wherein the downstream end of said first support is connected in fluid communication with the inlets of said tubes by a first passageway whose length does not exceed the length of the first

support and whose diameter is at no point less than the smaller of the diameter of said first support and the diameter of said shell;

(c) a first gas distributor upstream of the upstream end of said first support for distributing gas equally to all catalyst passages of said first support;

(d) a second catalyst system comprising a catalyst supported on a second monolithic unitary support having passages therethrough, the support having a length and upstream and downstream ends at opposite ends of the length, wherein the diameter of said second support is from one-half to two times the diameter of the shell of the heat exchanger, and wherein the upstream end of said second support is connected in fluid communication with the outlets of said tubes by a second passageway whose length does not exceed the length of the second support and whose diameter is at no point less than the smaller of the diameter of said second support and the diameter of said shell;

(e) a second gas distributor between the outlets of said tubes and the upstream end of said second support for distributing gas equally to all catalyst passages of said second support; and

(f) a source of gas to be purified in fluid communication with said upstream end of said support.

9. (new) Apparatus according to claim 8, further comprising

a second shell-and-tube heat exchanger comprising a shell inlet and a shell outlet in fluid communication with the shell inlet, and further comprising a plurality of tubes each having an inlet and an outlet,

wherein the downstream end of said second support of said second catalyst system is connected in fluid communication with the inlets of the tubes of said second heat exchanger by a passageway whose length does not exceed the length of said second support and whose diameter is at no point less than the smaller of the diameter of said second support and the diameter of said shell.

10. (new) Apparatus useful for purifying a gas stream, comprising

(a) a shell-and-tube heat exchanger comprising a shell inlet and a shell outlet in fluid communication with the shell inlet, and further comprising a plurality of tubes each having an inlet and an outlet;

(b) a first catalyst system comprising a catalyst supported on a first monolithic unitary support having passages therethrough, the first support having a length and upstream and downstream ends at opposite ends of the length, wherein the diameter of said first support is from one-half to two times the diameter of the shell of the heat exchanger, and wherein the downstream end of said first support is connected in fluid communication with the inlets of said tubes by a first passageway whose length does not exceed the length of the first support and whose diameter is at no

point less than the smaller of the diameter of said first support and the diameter of said shell;

wherein the shell outlet of the heat exchanger is connected in fluid communication to the upstream end of the first catalyst support;

(c) a first gas distributor between the shell outlet and the upstream end of the catalyst support, for distributing gas equally to all catalyst passages of the first catalyst support;

(d) a second catalyst system comprising a catalyst supported on a second monolithic unitary support having passages therethrough, the second support having a length and upstream and downstream ends at opposite ends of the length, wherein the diameter of said second support is from one-half to two times the diameter of the shell of the heat exchanger, and wherein the upstream end of said second support is connected in fluid communication with the outlets of said tubes by a second passageway whose length does not exceed the length of the second support and whose diameter is at no point less than the smaller of the diameter of said second support and the diameter of said shell;

(e) a second gas distributor between the outlets of said tubes and the upstream end of the second catalyst support, for distributing gas equally to all catalyst passages of the second catalyst support; and

(f) a source of gas to be purified in fluid communication with said shell inlet.